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E85-10029 NASA-CR-174120

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Task Assignment 110
July 1984

LANDSAT INSTRUMENTS CHARACTERIZATION
GSFC ATR - Dr. J. Barker
-SAR Task Leader - Dr. Y. Lee

Task Objective:

The objective of this task is to provide analytical and programming support for both Landsat-4 and -5 Thematic Mapper (TM) and Multispectral Scanner (MSS) instrument characterization, with emphasis on the radiometric performance.

Work Performed:

The following work was performed in the areas indicated.

210 CALDUMP and CALFILE Tapes Processing

The present CALDUMP tape consists of five calibration files and one reduced calibration file. The calibration files, each with data of 200 pixels, cover an entire calibration region starting from the 6251 minor frame (mf). Program LEE.FOR has been developed to edit these five files into seven .CAL files in the TAE mode. Program PCAL.FOR reads the .CAL files and plots the 1000 pixels of any scan line in linear or log scale. The typical spectra of the calibration region of forward and reverse scans are shown in Figures 1 and 2, respectively. It has been noted that the positions of the start and the end of shutter obscuration and the calibration pulse are shifted increasingly or decreasingly from Channel 1 to Channel 16, due to the timing of data acquisition.

To produce TRAPP-usable input files, the following procedures need to be taken: 1) determine the start of shutter obscuration position, 2) determine the calibration pulse and background region relative to the start of shutter obscuration, and 3) determine the end of shutter obscuration position.

The procedures for the determination of the start of shutter obscuration are 1) calculate the average background (B) and the associated standard deviation (δ_B) by use of data from 6650 mf to 6850 mf, 2) set up a threshold value $T = B+4\delta_B$, 3) find seven successive pixels from 6251 mf that are below threshold value, 4) search backward from the last position to find seven successive pixels that are above threshold value, 5) perform a linear regression of the last five pixels, and 6) calculate the intercept of the linear regression line and the average background to determine the start of shutter obscuration position. The preliminary result of the calculation shows a maximum variation of ~7 pixels existing along the scan.

The present CALFILE tape consists of more than 18 files. The telemetry information is contained in .CPD, .EPH, .HSD, .QAD, .SCD, .TAG, and .QAR files. DUMPSCD.EXE is the dump utility for these files. SCANCHR01.SCH contains the scan characterization information and the dump utility for this file is DUMPSCAN.EXE. CAL01.CAL is the reduced calibration file and the dump utility

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SCIENCE APPLICATIONS RESEARCH

is DUMPCAL.EXE. HIST001.HIS contains the histogram information and the dump utility is PLOTHIST.EXE. TL5CL*.PAR files are TIPS long-term parameter files and the dump utility is DUMPTLP.EXE. TS5***.PAR are TIPS short-term parameter files and the dump utility is DUMPTSP.EXE. Task personnel have processed the first CALFILE tape (path/row 20/37) and produced sample output for other investigators.

320 Coherent Noises

An algorithm for correction of coherent noises in TM imagery has been developed by using both image data and background data. This algorithm has the following procedures: 1) resequence the background data string and do the fast Fourier transform (FFT) on it, 2) set up a threshold value associated with the mean and the standard deviation in the FFT spectrum, 3) determine the noise peaks by comparing the FFT amplitude with the threshold value, 4) produce the amplitude, phase, and position of the coherent noises, 5) correct the band and odd/even channel offsets, resequence the image data string, and do the FFT on it, 6) remove the noises by the use of parameters obtained from background processing, 7) perform the inverse FFT to bring the calibrated data from the frequency domain back to the spatial domain, and 8) convert the data from real form to integer form by use of a probabilistic method. Typical FFT spectra of background data and image data are shown in Figures 3 and 4, respectively.

380 Miscellaneous Study

The full-scan line length variation along scan has been plotted out, shown in Figures 8 and 9, for the CCT-AT tape of scene ID 40488-16352. The line length varies from 6316 pixels to 6323 pixels. The possible bias of the image data caused by this variation need to be examined.

480 Absolute Radiometry

The scan-correlated shifts correction has been performed and applied on data of the four-sequence integrating sphere tests. The linear regression has been applied to the corrected data to produce a new set of absolute radiometric calibration parameters. The only significant changes occur in the calibrated offsets. The typical spectra of average background variation along scan before and after scan-correlated shifts correction are shown in Figures 5 and 6, and the gains, offsets, and standard deviation of the residuals of linear regression before and after correction are tabulated in Tables 1-3. Figure 7 shows a typical linear regression fit.

600 Investigator Support

Task personnel met with J. Kogut on July 2, 1984, regarding the absolute radiometric calibration.

Task personnel met with B. McKee on July 10, 1984, regarding the Landsat-5 band 6 geometric registration.

Task personnel met with A. Singh on July 5 and 24, 1984, regarding TIPS performance.

620 Tapes and Output Organization

Task personnel updated ORBIN.IN, the CALDUMP tape catalog. Task personnel organized material in Bldg. 16W (Rms 55 and 14) under the supervision of the ATR.

800 Data Processing

Task personnel processed one CALDUMP tape, one CALFILE tape, and 20 CCT-AT tapes.

Significant Accomplishments:

On their own initiative and with the ATR's approval, task personnel conducted a study of TM absolute radiometry before and after systematic noises correction. The results are tabulated in this monthly report.

Task personnel completed the preliminary processing of five-file CALDUMP and CALFILE tapes. This work was completed within a few days after receiving the tapes and was important to the TIPS production line. Many plots for the TM calibration region had been produced.

Task personnel provided a summary of TM absolute radiometric calibration to other Landsat investigators that should enable them to understand and study TM absolute radiometry.

Task personnel developed procedures for the batch job processing that increased the data processing speed to almost ten times faster than usual. This is very important to large volume data processing.

Problem Areas:

None.

Schedule Conformance:

Work is proceeding as planned in the revised milestone schedules.

Work Planned for Next Month:

210 CALDUMP and CALFILE Tapes Processing

Continue development of CALDUMP and CALFILE tapes processing.

320 Coherent Noises

Perform preliminary test of coherent noises correction.

Computer Utilization:

None.

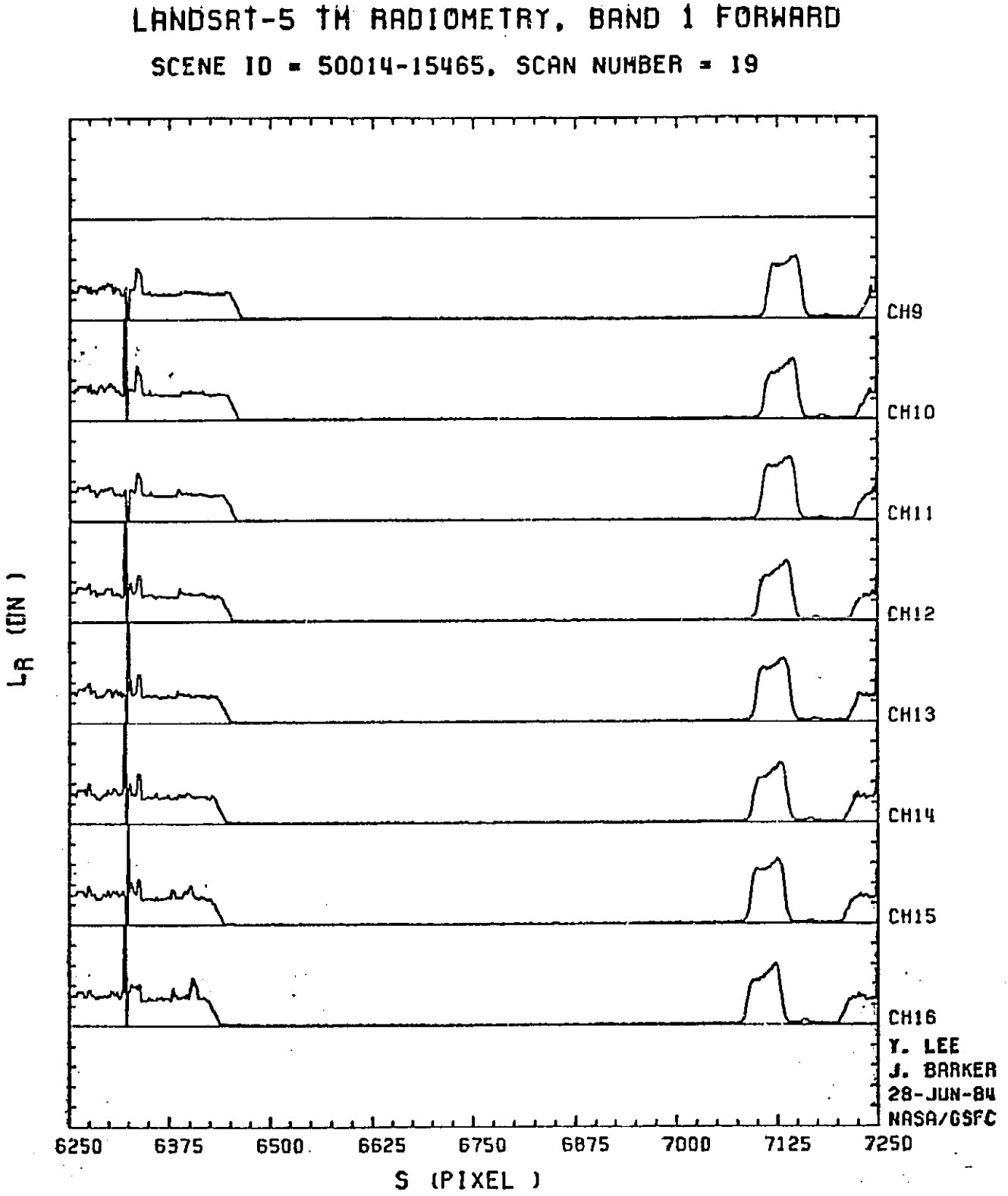


Figure 1 – Spectra of Forward Scan Calibration Region

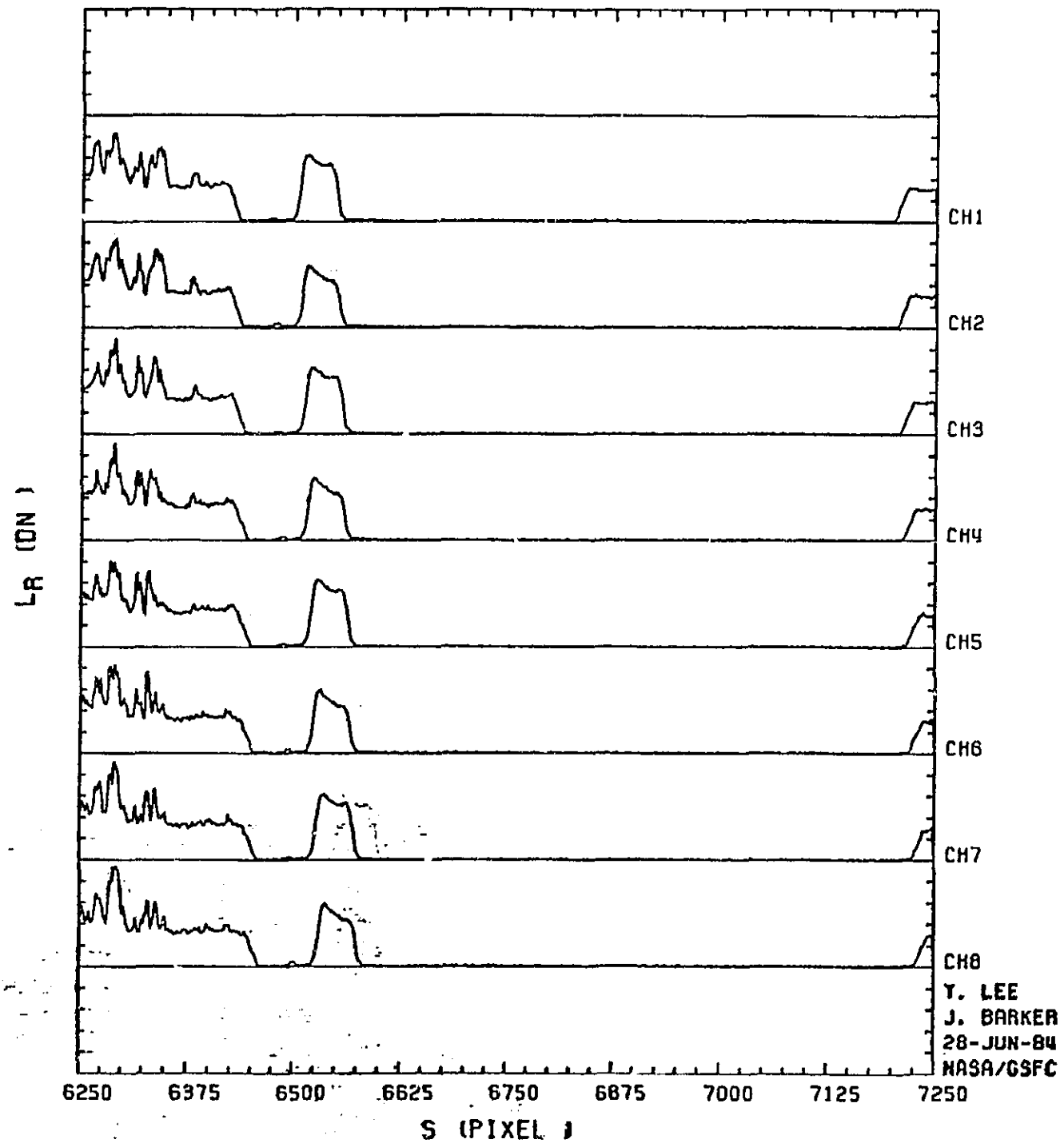


Figure 2 – Spectra of Reverse Scan Calibration Region

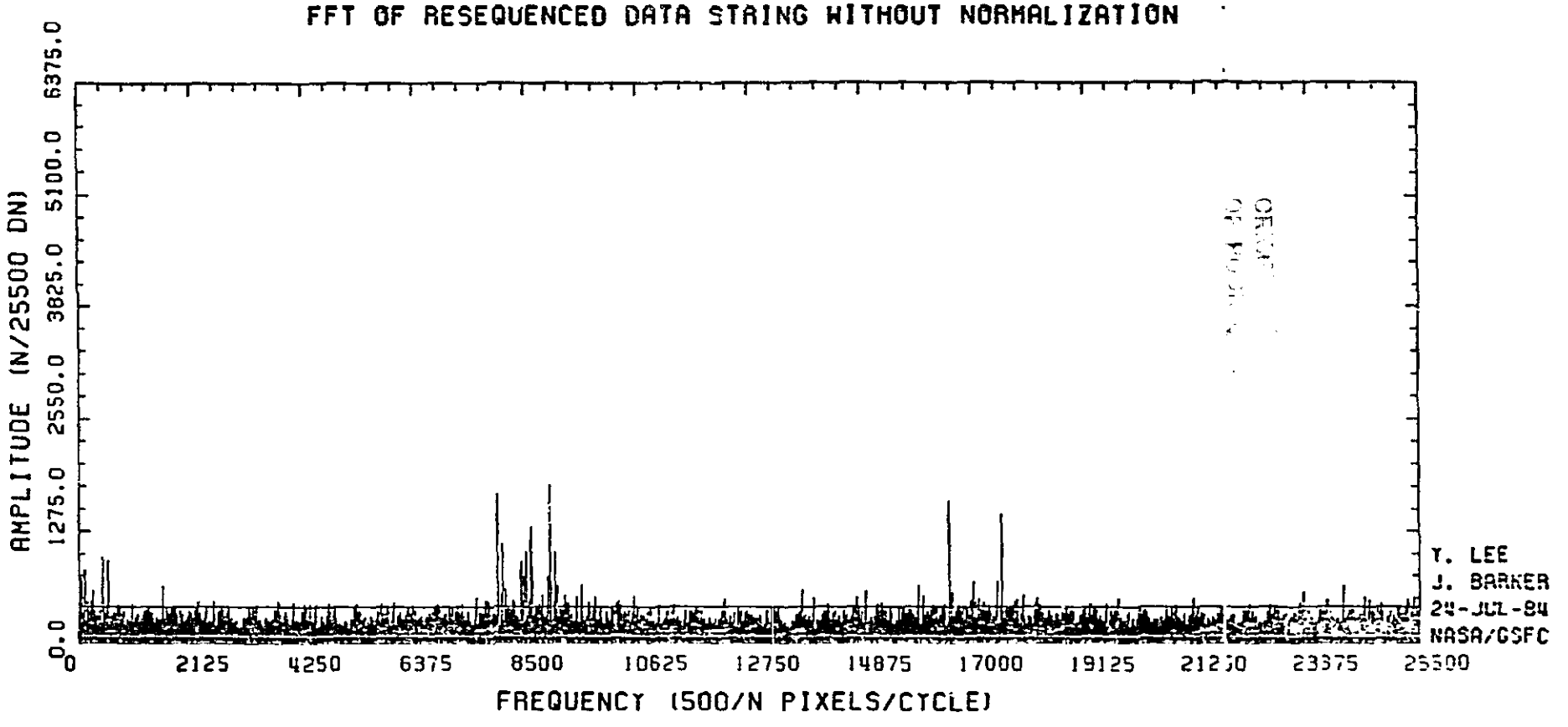


Figure 3 – Typical FFT Spectrum of Background Data

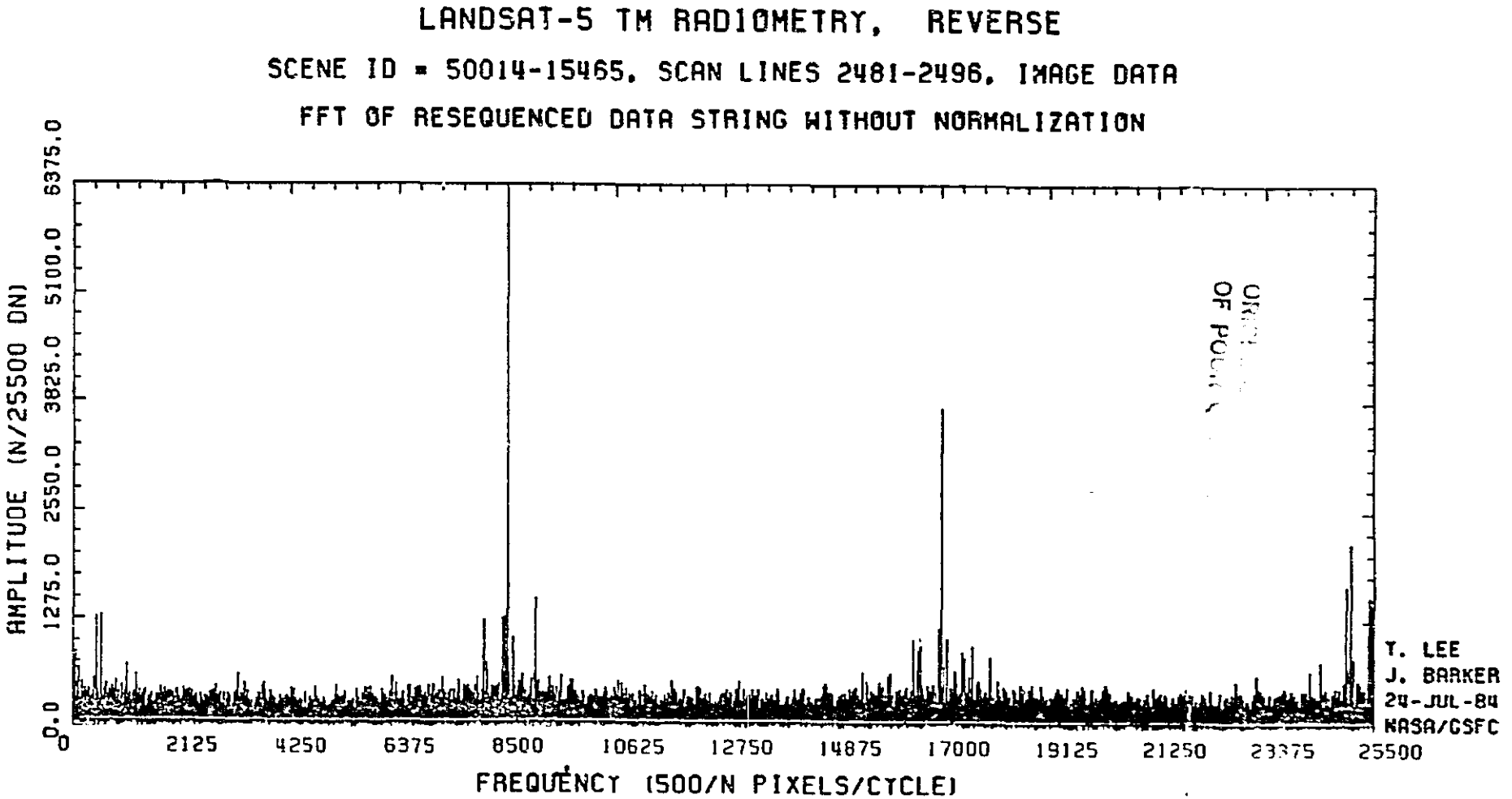
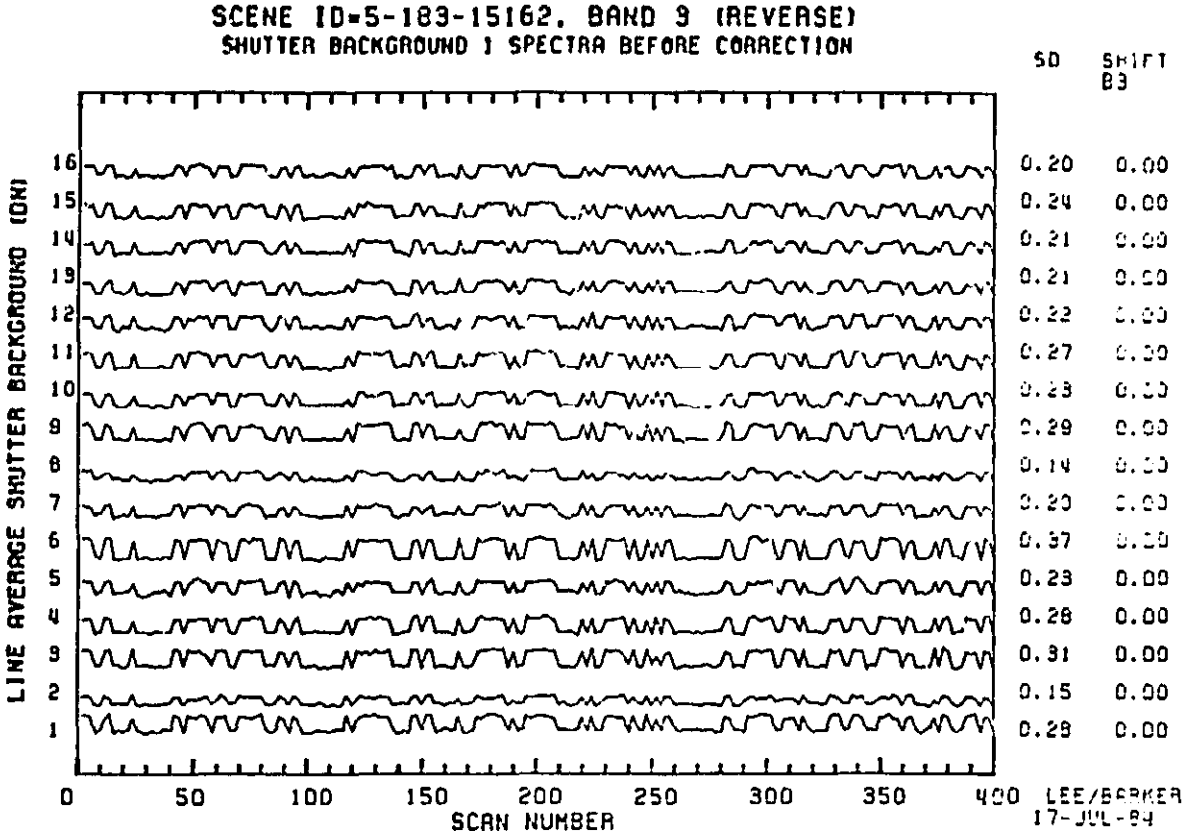


Figure 4 – Typical FFT Spectrum of Image Data



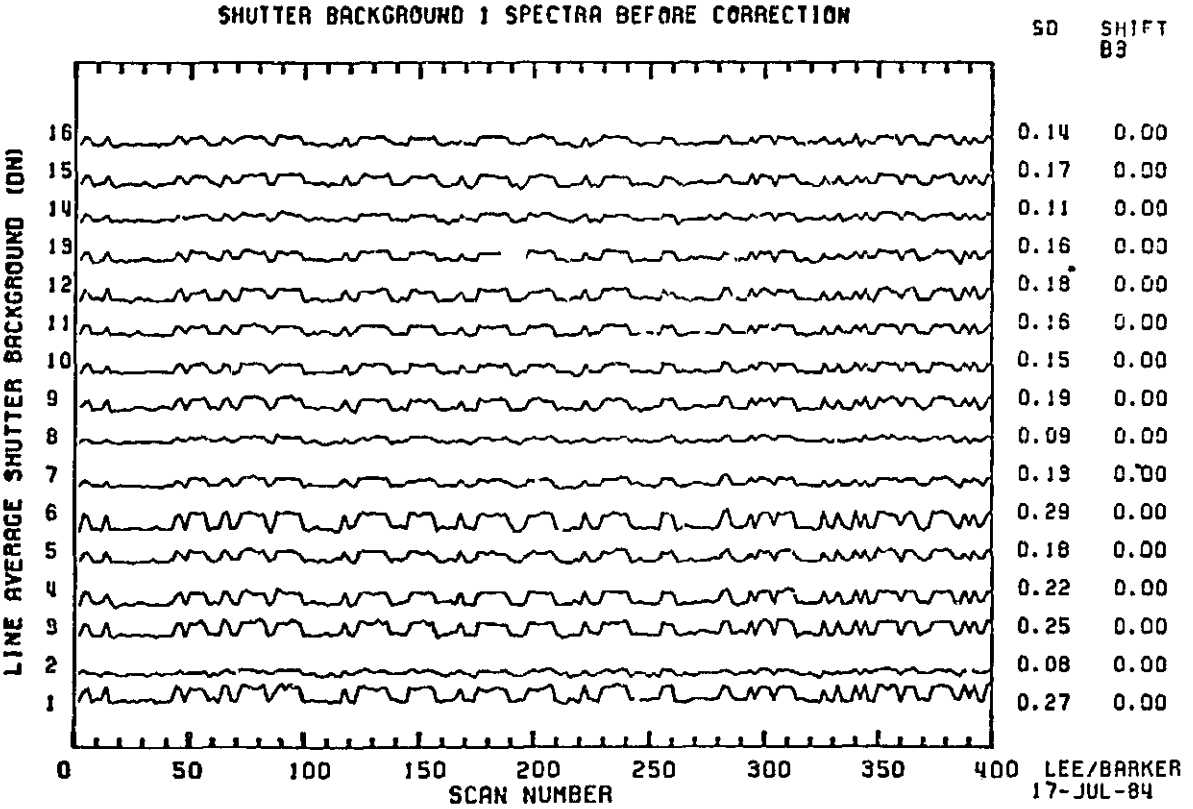


Figure 5 – Along Scan Variation of Average Background Before Scan-Correlated Shifts Correction

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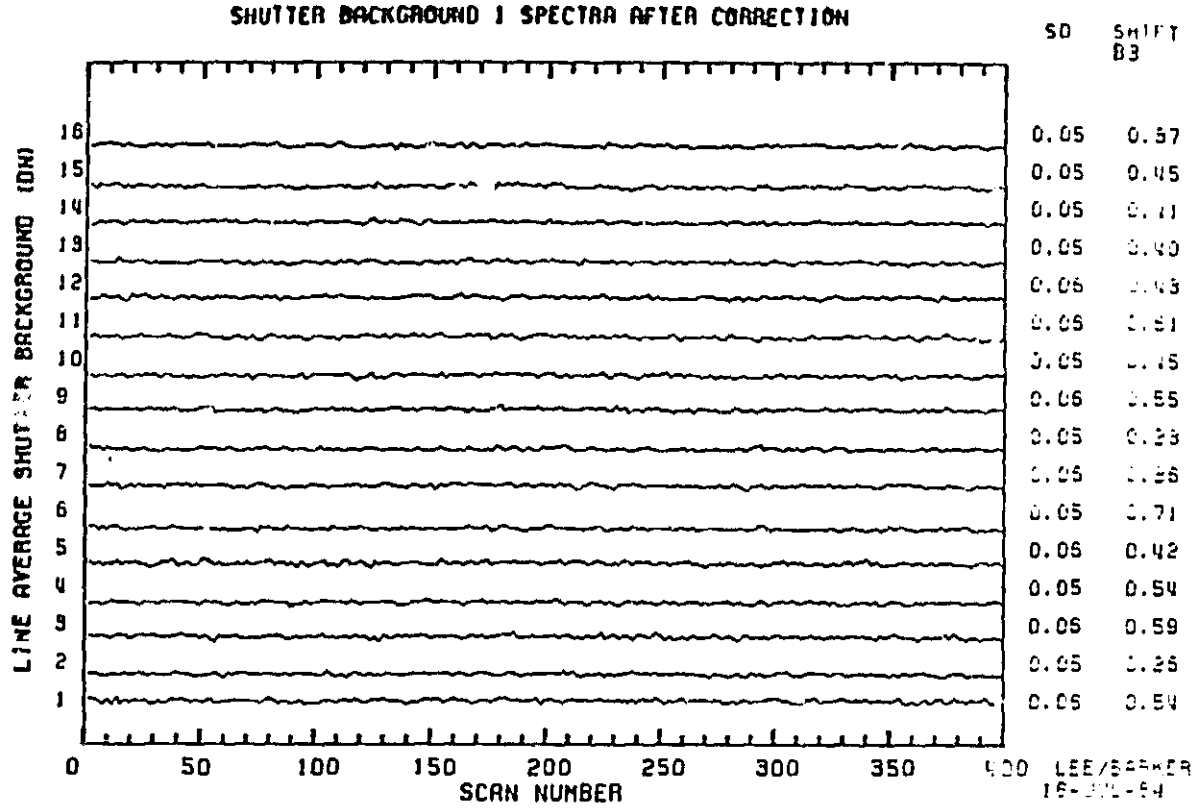


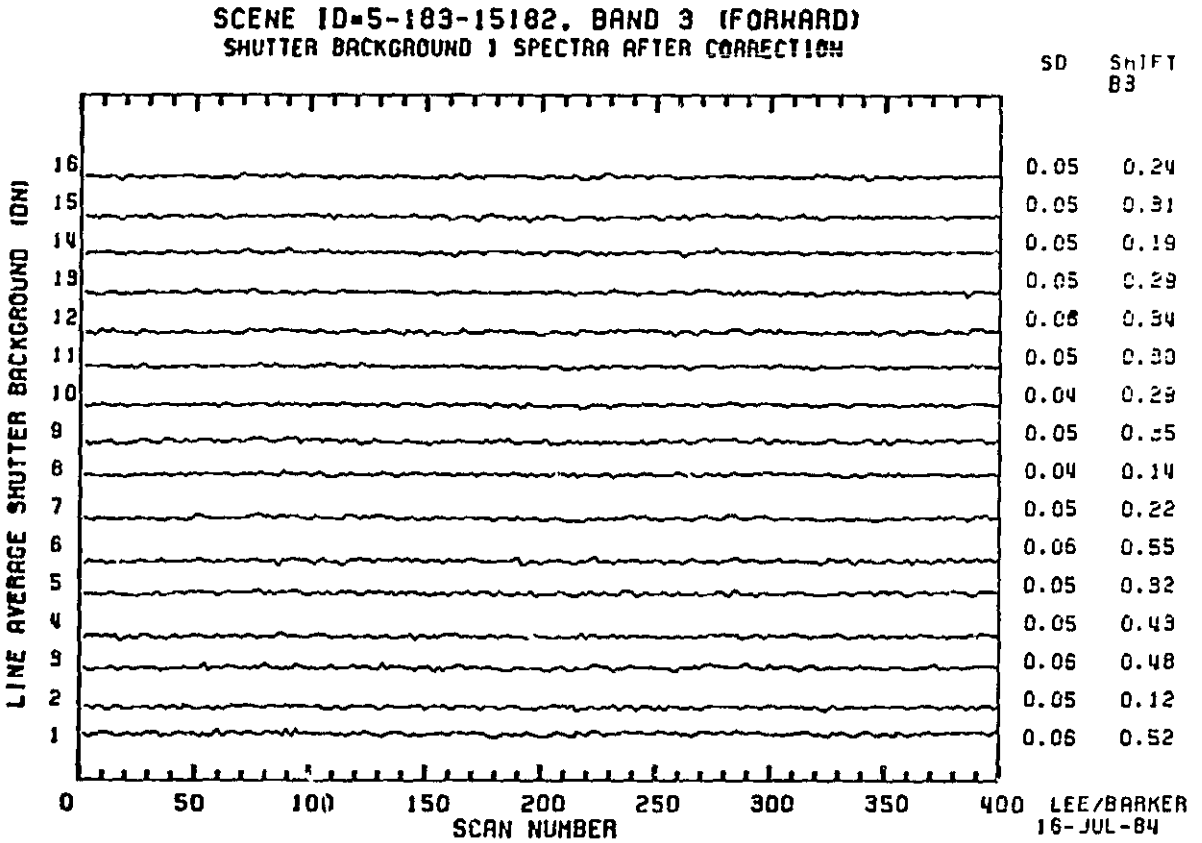
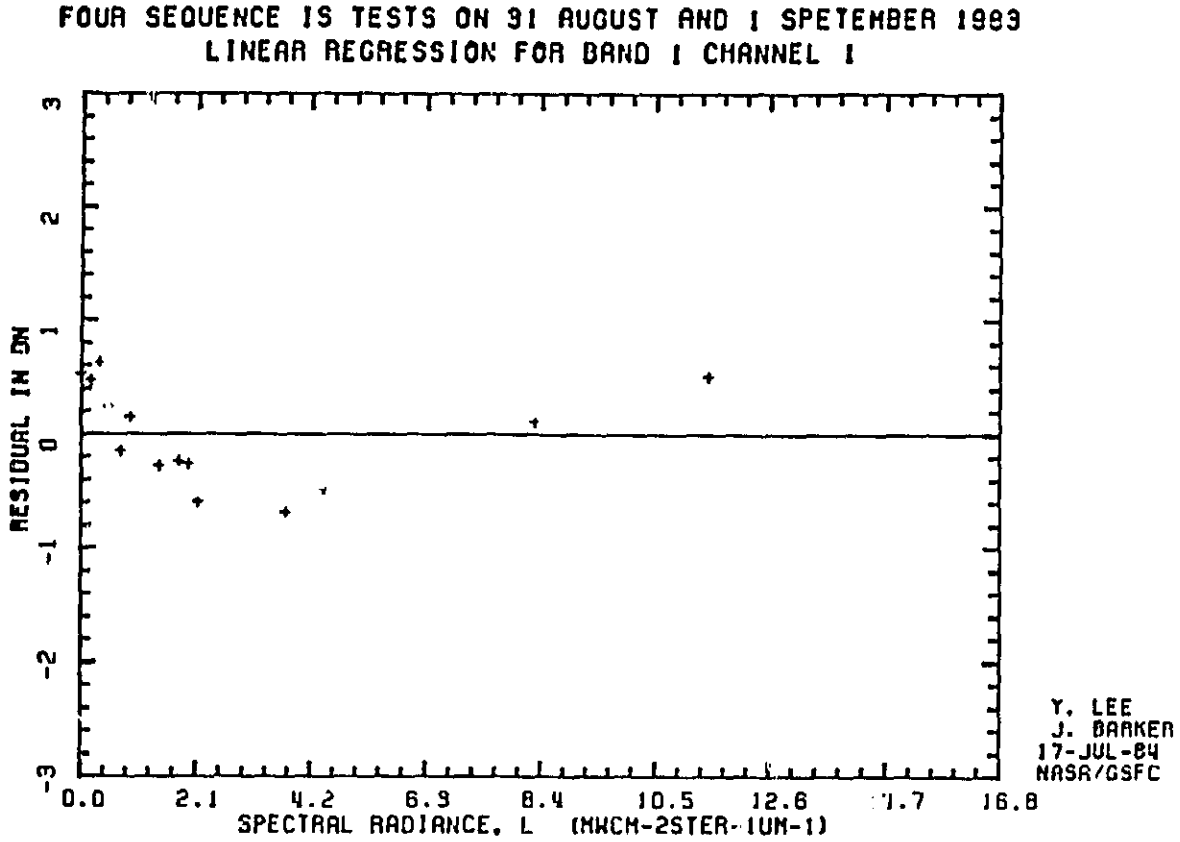


Figure 6 – Along Scan Variation of Average Background After Scan-Correlated Shifts Correction



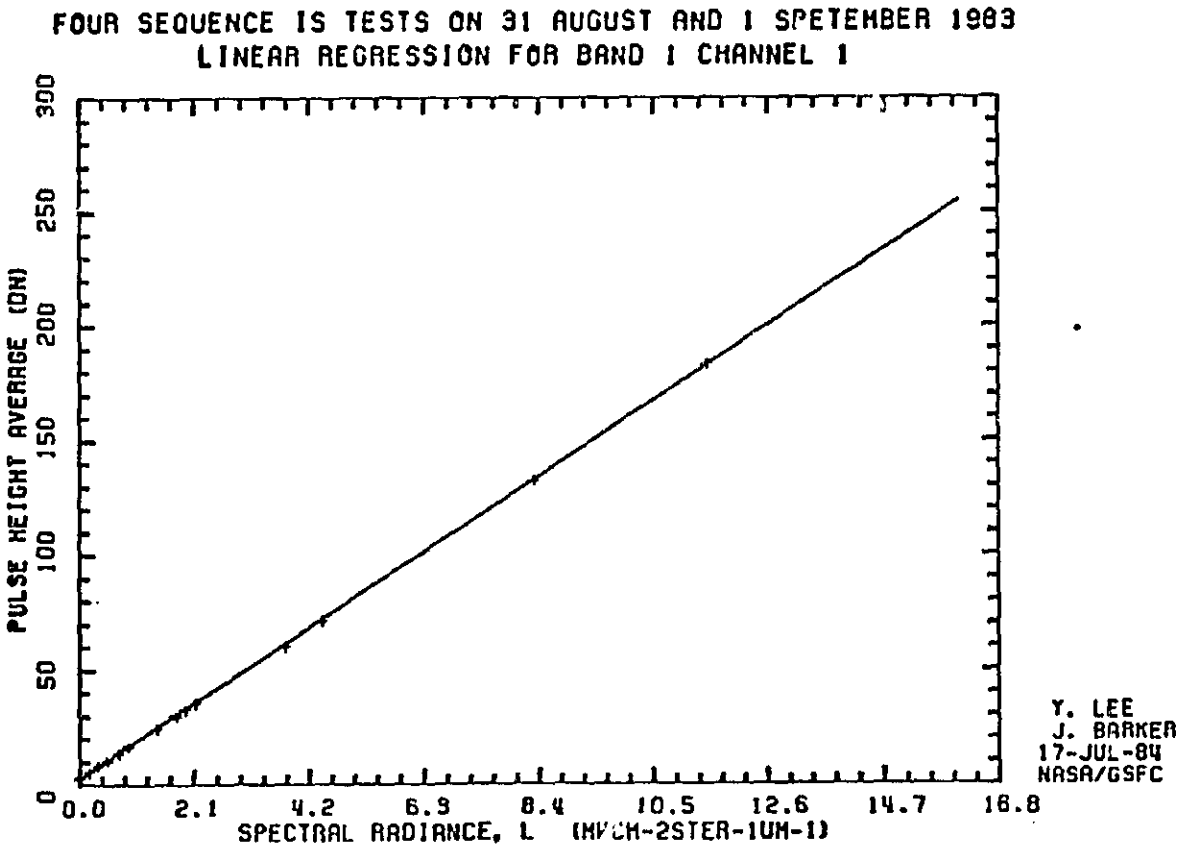


Figure 7 – Typical Linear Regression Fit of the Integrating Sphere (IS) Tests

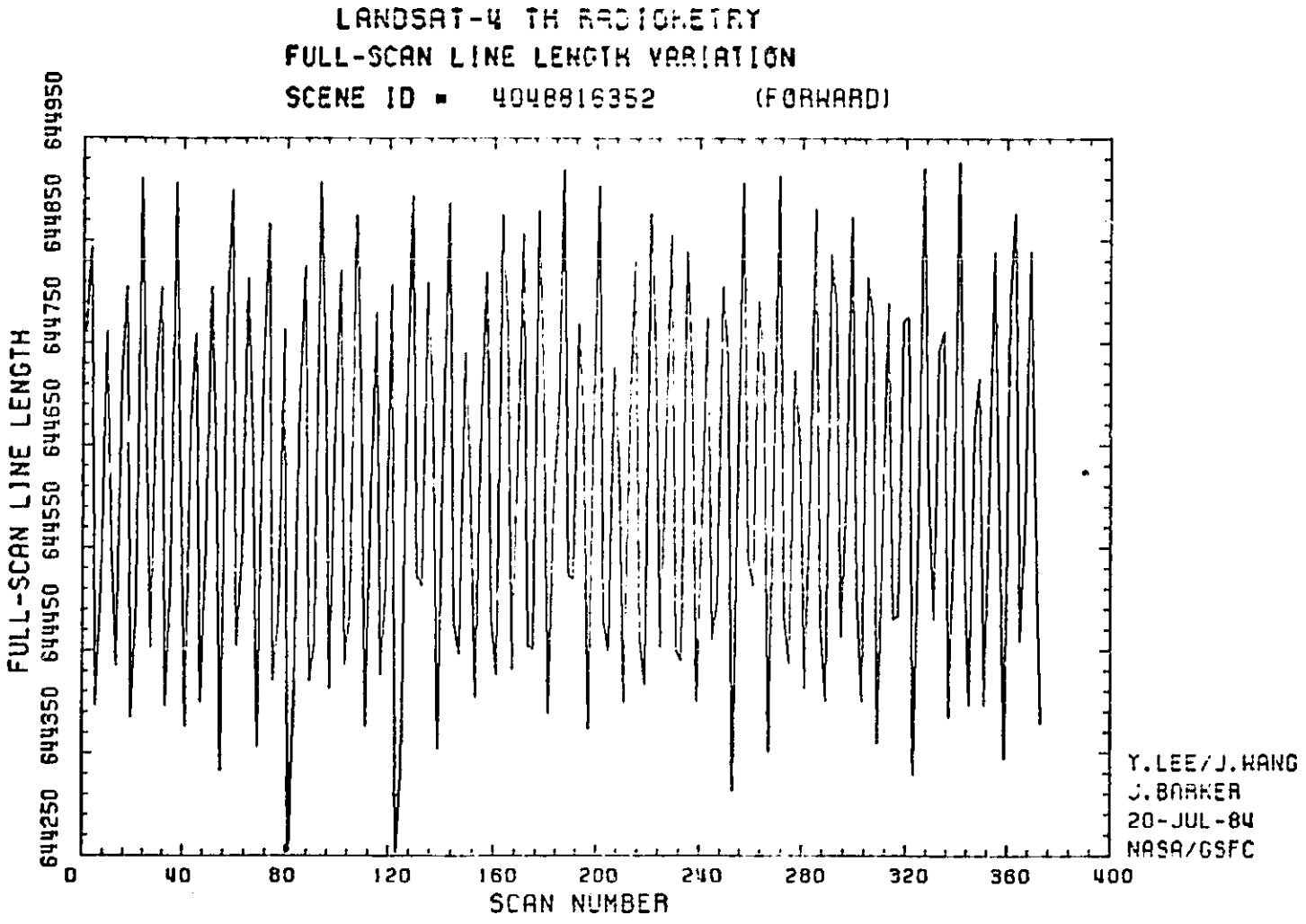


Figure 8 – Typical Spectrum of Forward Scan Line Length Variation, The unit in y-direction is sample, 1 pixel=102 samples.

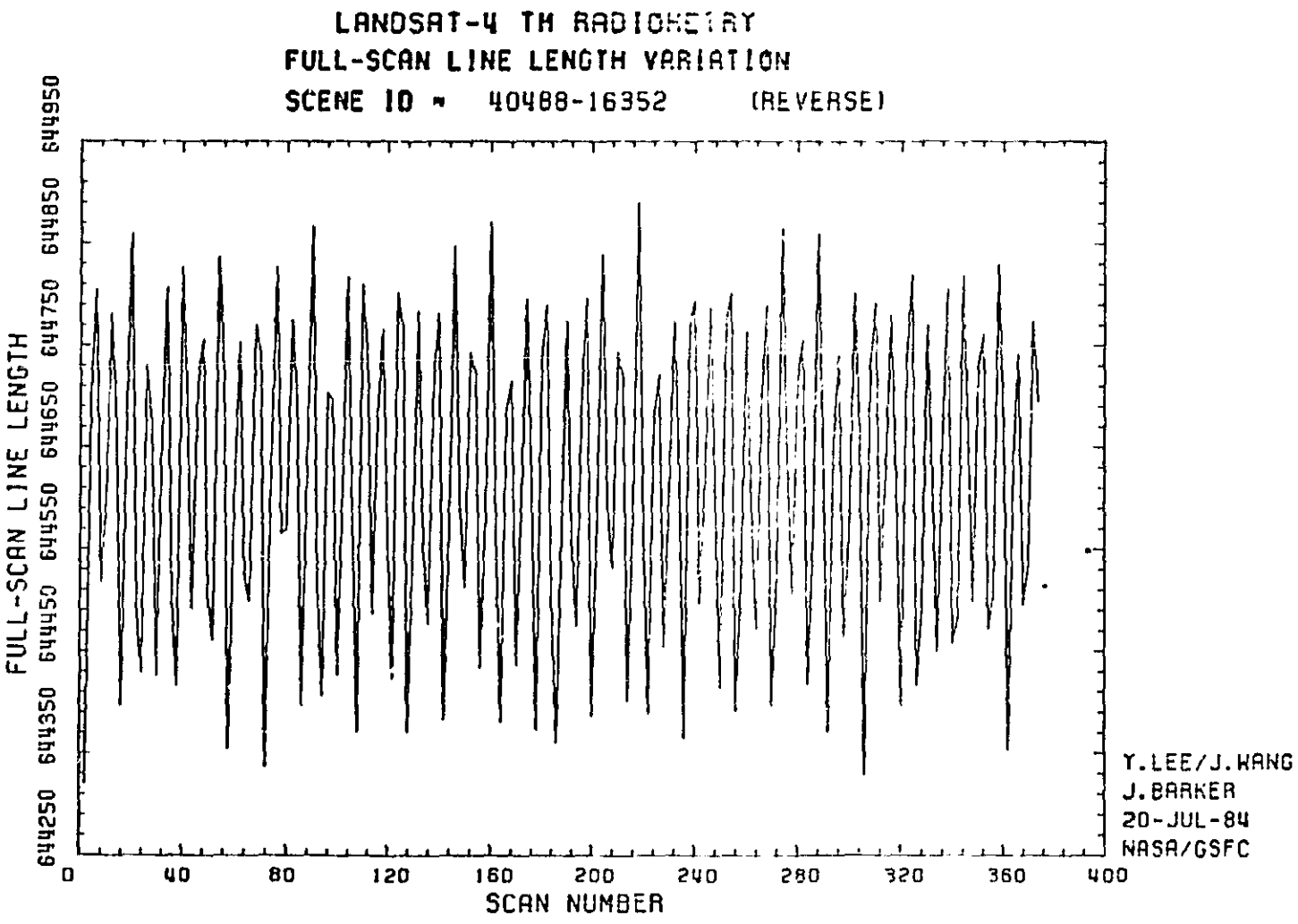


Figure 9 – Typical Spectrum of Reverse Scan Line Length Variation
The unit in y-direction is sample, 1 pixel = 107 samples

GAIN IN DN PER MWCM-2STER-1UM-1

15.7033	7.9015	10.1195	10.8963	79.1752	146.8021
15.5848	7.8711	10.2256	10.8528	78.2403	145.4346
15.7734	7.8633	10.0982	10.7838	78.7215	146.6512
15.5732	7.8656	10.1957	10.7403	78.3430	145.8331
15.8305	7.8772	10.1052	10.8330	78.8452	147.8937
15.5267	7.8385	10.0659	10.8190	78.7846	145.4647
15.7242	7.8535	9.9669	10.8115	78.2714	147.3223
15.5701	7.9433	10.1625	10.8996	79.6243	146.9702
15.6169	7.8249	10.0106	10.7354	78.9322	146.7371
15.6773	7.8961	10.1441	10.9435	78.9070	146.3412
15.7211	7.9186	10.0176	10.8102	79.4619	147.7086
15.6912	7.9427	10.2027	10.8205	79.2939	147.3909
15.6728	7.8967	10.0683	10.8086	78.9586	145.5525
15.5216	7.8594	10.1918	10.8721	78.5002	147.2444
15.6415	7.9359	10.1370	10.7900	79.0762	146.5186
15.6595	7.7943	10.2264	10.8705	79.2084	146.9155

OFFSET IN DN

2.3250	2.1358	2.6990	2.8151	3.0160	3.5527
1.9332	1.4555	2.1339	2.1927	2.6652	2.9863
1.8703	1.7525	2.2514	2.4633	2.7424	3.0754
1.8910	1.4397	1.9961	2.0339	2.7060	2.9983
1.7586	1.4208	2.1236	2.2115	2.5794	2.9076
1.9743	1.6777	2.0699	2.3030	2.6856	3.0036
1.7324	1.4832	2.1314	2.6106	2.6451	2.8542
2.1179	1.6196	2.1398	2.3001	2.9002	3.0123
1.6366	1.6209	2.2979	2.2206	2.6983	2.8950
1.7815	1.4997	2.0828	2.0760	2.7958	2.9593
1.5600	1.7007	2.1804	2.4390	2.7075	2.9023
1.7457	1.5028	2.0178	2.1154	2.7255	2.8485
1.6635	1.4927	2.0473	2.1923	2.6250	2.8286
1.8536	1.5319	2.0630	2.2103	2.7685	3.0431
1.6378	1.5268	2.0452	2.2299	2.6082	2.8776
1.8254	1.5284	2.1158	2.2069	2.7351	3.0465

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July 17, 1984
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Table 1 – Landsat-5 TM Post-Calibration Gains and Offsets Derived From 4-Sequence IS Tests Before Scan-Correlated Shifts Correction

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GAIN IN DN PER MWCM-2STER-1UM-1

15.7035	7.8986	10.1168	10.8919	79.1770	146.8145
15.5839	7.8718	10.2248	10.8539	78.2410	145.4288
15.7733	7.8613	10.0954	10.7862	78.7222	146.6632
15.5729	7.8667	10.1927	10.7402	78.3444	145.8471
15.8305	7.8757	10.1036	10.8339	78.8405	147.9041
15.5255	7.8377	10.0638	10.8190	78.7838	145.4736
15.7253	7.8511	9.9663	10.8129	78.2632	147.2814
15.5693	7.9426	10.1619	10.9006	79.6248	147.0087
15.6172	7.8239	10.0090	10.7366	78.9300	146.7159
15.6797	7.8959	10.1425	10.9436	78.9037	146.3887
15.7223	7.9178	10.0161	10.8116	79.4636	147.6898
15.6923	7.9426	10.2004	10.8211	79.2893	147.4046
15.6727	7.8943	10.0663	10.8083	78.9509	145.5456
15.5244	7.8574	10.1897	10.8737	78.5005	147.2452
15.6418	7.9340	10.1353	10.7907	79.0719	146.5253
15.6617	7.7887	10.2248	10.8737	79.2096	146.9276

OFFSET IN DN

2.3298	1.9167	2.4435	2.7357	2.9412	3.4996
2.0118	1.4072	2.0292	2.0783	2.6886	3.0391
1.8661	1.6585	2.0522	2.3093	2.6399	3.0478
1.9436	1.4160	1.8450	1.9398	2.7381	3.0592
1.7636	1.3298	1.9661	2.1616	2.5602	2.8610
2.0561	1.6621	1.9704	2.2755	2.7326	3.0635
1.7052	1.4268	1.9805	2.5500	2.6175	2.8041
2.1835	1.6116	2.0751	2.2688	2.9525	3.0778
1.6340	1.5842	2.1671	2.1338	2.6534	2.8204
1.8650	1.4972	2.0103	2.0671	2.8308	3.0217
1.5569	1.6488	2.0471	2.3361	2.6412	2.8456
1.8190	1.4954	1.8693	2.0861	2.7977	2.9076
1.6756	1.4257	1.8940	2.1353	2.5720	2.7864
1.9356	1.5126	1.9769	2.1486	2.8085	3.1071
1.6550	1.4576	1.9052	2.1527	2.5965	2.8323
1.8825	1.4540	1.9994	2.1093	2.7893	3.1041

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Table 2 - Landsat-5 TM Post-Calibration Gains and Offsets Derived From 4-Sequence IS Tests After Scan-Correlated Shifts Correction

STANDARD DEVIATION OF GAIN AND OFFSET FIT

0.4408	0.3822	0.4433	0.5317	1.1256	0.7294
0.4811	0.4416	0.4650	0.6091	1.0971	0.7176
0.4558	0.3782	0.4569	0.4517	1.1037	0.7129
0.4714	0.4411	0.4861	0.6659	1.1085	0.7090
0.4561	0.4105	0.4547	0.5105	1.1609	0.7276
0.4800	0.3712	0.4336	0.5559	1.1379	0.7158
0.4293	0.4091	0.4421	0.3702	1.1259	0.7297
0.4638	0.3819	0.4926	0.5264	1.1505	0.7423
0.4443	0.4055	0.4235	0.5722	1.1555	0.7001
0.4561	0.4630	0.4495	0.5705	1.0841	0.7137
0.4671	0.3504	0.4467	0.4509	1.1765	0.7330
0.4741	0.4453	0.4758	0.5971	1.1626	0.7362
0.4581	0.4250	0.4385	0.5261	1.1540	0.6867
0.4807	0.4331	0.5089	0.5595	1.1227	0.7496
0.4481	0.4404	0.4677	0.5205	1.1711	0.6994
0.4808	0.4108	0.5065	0.6306	1.1271	0.7358

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OVERALL STANDARD DEVIATION = 6.5796

Table 3.a – Standard Deviation of Linear Regression Fit of Abrolute Calibration Before Scan-Correlated Shifts Correction

STANDARD DEVIATION OF GAIN AND OFFSET FIT

0.4419	0.4117	0.4363	0.5509	1.1291	0.7364
0.4725	0.4397	0.4612	0.6025	1.0982	0.7091
0.4592	0.3865	0.4681	0.4440	1.0990	0.7186
0.4667	0.4379	0.5067	0.6810	1.1094	0.7104
0.4601	0.4153	0.4850	0.5059	1.1530	0.7314
0.4707	0.3725	0.4768	0.5499	1.1393	0.7179
0.4363	0.4123	0.4378	0.3776	1.1088	0.7195
0.4562	0.3815	0.4920	0.5162	1.1562	0.7572
0.4464	0.4019	0.4366	0.5585	1.1403	0.6922
0.4481	0.4626	0.4732	0.5670	1.0944	0.7306
0.4683	0.3496	0.4626	0.4444	1.1746	0.7246
0.4670	0.4454	0.4830	0.5867	1.1686	0.7391
0.4598	0.4242	0.4414	0.5258	1.1551	0.6854
0.4752	0.4325	0.5088	0.5446	1.1271	0.7474
0.4503	0.4390	0.4734	0.5088	1.1704	0.7034
0.4810	0.4372	0.5057	0.6042	1.1304	0.7383

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OVERALL STANDARD DEVIATION = 6.5835

Table 3.b – Standard Deviation of Linear Regression Fit of Absolute Calibration After Scan-Correlated Shifts Correction